

Reservoir Fisheries in India

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ASSESSMENT OF OPTIMUM FISH YIELDS FROM RESERVOIRS IN TAMIL NADU

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Time series data on catch and effort for the early sixties to the mid eighties have been used for the assessment of optimum yield from five reservoirs in Tamil Nadu by using Schaefer and Fox models. Fishing in respect of all these reservoirs has almost reached the optimum levels. The MSY is about 260,000 kg for the optimum effort (f_{msy}) of 200,000 gillnetdays for the Bhavanisagar reservoir where the average annual catch was 193,488 kg for 123,333 gillnetdays during 1971-84 and the maximum catch was 340,560 kg for 258,000 gillnetdays in 1981-82. For the Sathanur reservoir, the MSY is 165,000 kg for the f_{msy} of 38 coracle units per day, while the average annual catch was 128,688 kg for an average annual effort of 21 coracle units per day during 1966-84 and the maximum catch was 195,000 kg for 39 coracle units per day in 1980-81. The estimated MSY for the Amaravathy reservoir is 183,000 kg for the f_{msy} of 3,800 coracledays, the mean annual catch during 1961-84 was 71,520 kg for a mean annual effort of 2,507 coracledays and the maximum catch was 160,000 kg for 6,570 coracledays in 1981-82. In respect of Mettur reservoir, the MSY is 400,000 kg to 500,000 kg for the f_{msy} of 1000-1200 coracle units per day, the average annual catch for 1963-84 was 351,374 kg for an average annual effort of 494 coracle units per day and the maximum catch was 579,540 kg for 743 coracle units per day in 1979-80. In the case of Ooty lake, the MSY is 5,600 kg for the f_{msy} of 4,000 gillnetdays while the average annual catch was 5,325 kg for the average annual effort of 3,225 gillnetdays during 1972-82 and the maximum catch was 8,600 kg for an effort of 2,100 gillnetdays in 1978-79.

Introduction

The Tamilnadu state in India has substantial reservoir resources for the development of fisheries. Despite considerable development of reservoir fisheries in this state, there has not been any significant study in regard to the assessment of the fishery potential of these reservoirs. The present study deals with the estimation of optimum yields in respect of four irrigation reservoirs, namely, Bhavanisagar, Sathanur, Amravathy, Mettur and the Ooty lake.

Materials and methods

The maximum sustainable yield (MSY) which is considered to be the biologically optimum yield, was estimated by means of the Schaefer (1954) and Fox

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(1970) models using time series data on catch and effort. The model takes account of the fact that the yield per unit effort (Y/f) is a monotonically decreasing function of fishing effort (f), expressed by the equations,

$$\text{Schaefer} \quad : \quad Y/f = a - bf \quad \dots\dots\dots (1)$$

$$\text{Fox} \quad : \quad Y/f = \exp. a + bf \quad \dots\dots\dots (2)$$

so that the absolute yield (Y) is a parabolic function of f ,

$$Y = af - bf^2 \quad \dots\dots\dots (3)$$

$$Y = \exp. af + bf^2 \quad \dots\dots\dots (4)$$

From the constants a and b of equations (1) and (2) the MSY and corresponding f_{msy} considered to be the biologically optimum effort, are estimated by the following expressions.

$$\text{Schaefer} \quad : \quad MSY = -a^2/4b \quad \dots\dots\dots (5)$$

$$f_{msy} = -a/2b \quad \dots\dots\dots (6)$$

$$\text{Fox} \quad : \quad MSY = -(1/b) e^{(a-1)} \quad \dots\dots\dots (7)$$

$$f_{msy} = -1/b \quad \dots\dots\dots (8)$$

Each fishing unit generally consists of a coracle, an indigenous circular boat made of bamboo splints and buffalo hide, varying number of gillnets and a crew of two fishermen. Besides gillnets, other fishing gears are also operated sometimes. Only in the case of Ooty lake motorised boats are used as fishing craft, instead of coracles. The operation of one such fishing unit over a complete day constitutes one unit effort called coracleday or boatday. For some reservoirs, however, effort is expressed in terms of gillnetdays, for example, if 10 coracles operated 40 gillnets each daily for 365 days, the annual effort is computed as 146,000 gillnetdays (Table 1). The gillnets are left suspended in the water column round the clock and the catches removed every morning. At weekends, they are removed, repaired, dried and again released. In the case of some reservoirs, licences are issued in the beginning of each year for a fixed number of fishing units of the above types, but the number of licences may vary from year to year, while in others fishing is carried out by the Department of Fisheries itself. The details of fishing units and fishing effort are given in Table 1.

The various species in the catch were grouped according to the nature of their food into planktivores, herbivores, periphyton-cum-decaying organic matter feeders, second level carnivores (which feed essentially on benthic invertebrates and small fishes) and third level carnivores (which feed essentially on fishes) in order to determine the relative abundance of the different feeding groups in the reservoirs (Table 3). The species composition in the catches was used as the basis for apportioning the total MSY among the various feeding groups and the species comprising them.

Results and discussion

1 Bhavanisagar reservoir

The regression of Y/f in kg on annual f in gillnetdays according to equations (1) and (2) for the period 1971-72 to 1983-84 (excluding 1982-83) has been found to be :

$$\text{Schaefer} : Y/f = 2.92422 - 0.00000803 f \quad \dots\dots (9)$$

$$\text{Fox} : Y/f = \exp. 1.11176 - 0.00000430 f \quad \dots\dots (10)$$

The annual MSY is estimated to be 266,307 kg (Schaefer) and 259,828 kg (Fox) for f_{msy} of 182,139 (Schaefer) and 232,354 (Fox) gillnetdays respectively. The coefficient of determination (r^2) is 0.67 for the Fox estimate and 0.59 for the Schaefer estimate (Table 2).

The annual catch during this period ranged from about 70,090 kg for an effort of 43,000 gillnetdays in 1983-84 to 340,560 kg for 258,000 gillnetdays in 1981-82, while the average annual catch was 193,488 kg for the average annual effort of 123,333 gillnetdays. Evidently there is good scope for enhancing the fishing effort from the average of 123,333 gillnetdays to the optimum of 232,354 gillnetdays to realise the MSY of 259,828 kg a year.

At the rate of 43 nets per coracle for 365 days, the f_{msy} of 232,354 gillnetdays is equivalent to 15 coracle units per day operating all round the year. The number of coracle units per day was only 2 in 1971-72 and 1972-73, 5 in 1973-74, 7 during 1974-75 to 1977-78, 10 in 1978-79, 13 in 1979-80 and 16 in 1980-81 and 1981-82, but decreased to 3 in 1983-84 due to extremely low water conditions. The annual effort ranged from 30,000 gillnetdays in 1971-72 (catch 94,200 kg) to 258,000 gillnetdays in 1981-82 (catch 340,560 kg). The extremely high catch in 1981-82 (340,560 kg) was due to very low level of water in the reservoir. The average annual catch for the 1977-78 to 1983-84 period for which species composition data is available was 212,900 kg. Evidently, the fishery in recent years seems to have stabilized almost close to the MSY level.

During 1977-78 to 1983-84, the periphyton-cum-decaying organic matter feeders (PDOMF), the second level carnivores (SLC), the third level carnivores (TLC) and the planktivores constituted 64.02%, 23.07%, 11.83% and 1.03% respectively of the average annual catch of 212,900 kg. In 1964 these categories formed 31.93%, 48.98%, 10.23% and 8.3% respectively, revealing thereby, a substantial increase in the PDOMF group and decline in the SLC, mainly on account of the dwindling of the *Puntius dubius* stock. The stock of *Mystus aor* and *Mystus seenghala* remained at the same level. Among the PDOMF group, *Labeo rohita* and *Labeo fimbriatus* increased very significantly from 1964 to 1977-84 while *Labeo calbasu* which held the first position in 1964 was slightly exceeded by *L. fimbriatus* in 1977-84. The annual increase in the

organic silt load in the reservoir seems to be responsible for the growth of the PDOMF fishery. *P. dubius* eggs are adhesive and demersal and are deposited on rocky river beds. Evidently, the increasing silt load on these beds has led to the progressive decline in the fishery for this species in the reservoir.

The gross photosynthetic productivity in Bhavanisagar reservoir has been found to be $(8.162 \text{ cal/m}^2/\text{year}) \times 10^6$ (Sreenivasan, 1969 a) or $6.2 \text{ gO}_2/\text{m}^2/\text{day}$ (Sreenivasan, 1969 b). Following Ganf (1972, 1974) 8% of gross photosynthetic production, i.e., $0.496 \text{ g O}_2/\text{m}^2/\text{day}$ is taken to be the net production, which is equivalent to $0.1488 \text{ g C/m}^2/\text{day}$ ($0.496 \times 0.375/1.25$). At this rate, the annual primary production for an area of 3,695 ha at mean reservoir level (MRL) is 1953.96 tons carbon, equivalent to a wet weight of 14,596.1 tons. The average annual yield of 193,488 kg represents 1.33% which compares very well with the values of 1.5% for the equatorial lake George and 1.2% for the North Sea where the secondary consumers are predominant (Melack, 1976). The annual MSY estimate of 259,828 kg for Bhavanisagar represents 1.80% of primary production in wet weight. Considering that the fishery is mainly constituted by the PDOMF group (64.02%), the actual conversion ratio of 1.80% seems quite possible.

Melack (1976) fitted fish yield (FY) in kg per hectare per year as a function of gross photosynthesis (GP) in $\text{g O}_2 \text{ per m}^2 \text{ per day}$ for 15 ponds, tanks, streams and lakes including Bhavanisagar as follows (with a coefficient of variation of 0.82).

$$\log \text{FY} = 0.95 + 0.122 \text{ GP}$$

Bhavanisagar reservoir has an area of 7,720 ha at full reservoir level (FRL) and 3,695 ha at mean reservoir level while the mean depth is 11.10 m. According to Sreenivasan (1964, 1974), this reservoir is characterised by a strong oxycline, kilinograde distribution of oxygen, accumulation of carbondioxide and low pH in the bottom layers and chemical (bicarbonate) stratification, which support high photosynthetic and tropholytic activities. The organic carbon and nitrogen level is fairly high (Anon., 1981). In spite of high phytoplankton productivity, *Catla catla* has failed to establish itself into a viable stock, and therefore, it is necessary to stock this reservoir with the fingerlings (8 to 10 cm long) of this species at the rate of about 750 fingerlings per hectare every year and reduce predatory fishes like *Wallago attu* by selective fishing using hook and lines.

2 Sathanur reservoir

Equationss (1) and (2) for the regression of Y/f in kg (catch per coracle unit per year) on f (in number of coracle units per day for all the 365 days a year) for the 16 years from 1966-67 to 1983-84 (excluding 1975-76 and 1976-77), have been fitted to be :

Schaefer	: $Y/f = 10605.9 - 154.882 f$	(11)
Fox	: $Y/f = \exp. 9.3802 - 0.026271 f$	(12)

The annual MSY is estimated to be 181,566 kg (Schaefer) and 165,955 kg (Fox) for the f_{msy} of 34 coracle units per day (Schaefer) and 38 coracle units per day (Fox) respectively for all 365 days a year. The r^2 value is found to be 0.63 and 0.69 for the Schaefer and Fox estimates respectively.

The annual catch ranged from 45,000 kg in 1966-67 for an effort of 6 corecle units per day for 365 days a year to 184,000 kg in 1977-78 (almost equal to the Schaefer estimate for MSY) for 19 corecle units per day which is nearly half the f_{msy} of 34 to 38 units. The fishing effort progressively increased from 6 coracle units per day in 1966-67 and 1967-68 through 8 units in 1968-69, 12 units during 1969-70 to 1971-72, 14 units in 1972-73, 15 units both in 1973-74 and 1974-75, 19 units in 1977-78 and 21 units in 1978-79 to 39 to 40 units since 1979-80. The current effort of 40 units since 1979-80 is almost equivalent to the f_{msy} of 34 units (Schaefer) and 38 units (Fox) while the current average annual catch of 158,000kg during this period is nearly equal to the MSY of 165,955 kg (Fox) and 181,566 kg (Schaefer).

Species composition for the period 1977-78 to 1983-84, when the average annual catch was 128,687 kg, indicates that the fishery was constituted by the planktivores (66.78% - exclusively of *C. catla*), the PDOMF group (28.4% comprising 11.43% *Cirrhinus mrigala*, 7.25% *L. rohita*, 4.06% *L. fimbriatus*, 3.22% *L. calbasu*, 1.71% *Cirrhinus cirrhosa* and 0.7304% others), the SLC group (2.72%, almost exclusively of *Mystus* spp except rare catches of freshwater prawns) and the TLC group (2.09% accounted for by *W. attu*).

Located at an altitude of 230 m above MSL, the reservoir has an area of 1,635 ha at FRL. Though favourable morphometric, edaphic and thermal conditions prevail, primary productivity was found to be low owing to high turbidity (Sreeniyasan, 1968). However, the planktivore *C. catla*, one of the planted species, established well in the reservoir, apparently because of the low density of predators like *W. attu*.

3 Amaravathy reservoir

The regression of Y/f in kg on annual effort f in terms of units, each consisting of 15 nets (5 bottom set gillnets of 60 x 0.75 m each and 10 Rangoon nets of 100 m each), operated by two fishermen from a coracle for the period of 1961-62 to 1983-84, is found to be :

$$\text{Schaefer : } Y/f = 96.3106 - 0.0125278 f \quad \dots\dots\dots (13)$$

$$\text{Fox : } Y/f = \exp. 4.0665 - 0.0002578 f \quad \dots\dots\dots (14)$$

The annual MSY is estimated to be 182,550 kg for the f_{msy} of 3,855 coracledays per year at the rate of 10 coracle units per day (Schaefer) and 83,961 kg for the f_{msy} of 3,833 coracledays per year at the rate of 10 coracle units per day (Fox). The r^2 value is 0.35 for the Schaefer estimate and 0.21 for the Fox estimate.

In the 16-year period from 1961-62 to 1976-77, when 2 coracle units operated per day with an annual effort of 730 coracle days, the annual catch ranged from a minimum of 360 kg in 1961-62 (apparently due to the inexperience of the fishermen in the first year of the fishery) to the maximum of 132,000 kg in 1973-74 (mean 62,591 kg). With the abrupt increase in effort to 18 units per day, resulting in an annual effort of 6,570 coracle days, the average annual catch increased to 101,000 kg which was much less than the MSY of 182,550 kg (Schaefer).

The fishery of Amaravathy reservoir is predominantly of *Oreochromis mossambicus* (81.70%) followed by the other members of the PDOMF group (15.79%), the TLC (0.33%) and the SLC (0.16%). Evidently the poor stocks of the SLC and TLC groups seem to have facilitated higher yields from the PDOMF group.

The Amaravathy reservoir is of medium size with a waterspread area of 907 ha at FRL and a mean depth of 10.15 m. This reservoir has been considered to be a typical bluegreen algal biotope (Sreenivasan, 1965 a and b; 1967). Despite the considerable depth, thermal stratification was negligible, but there was a regulated and distinct oxygen stratification. The primary productivity was as high as 6.8 g O₂/m²/day. The very poor chloride content indicates that the reservoir is free from any pollution.

Numerous tilapia breeding pits of about one meter diameter are seen along the margin of the reservoir. In view of the persistent blooms of bluegreen algae, fingerlings of typical planktivores like *C. catla* and the silver carp (*Hypophthalmichthys molitrix*) may be stocked to balance or reduce the tilapia population, and thereby, to increase the value of the harvest. At present the planktivores are very insignificant (0.961%) in the catch. Fingerlings or yearlings of grass carp (*Ctenopharyngodon idella*) could also be stocked to control the abundant weeds which at present are a hazard to fishing.

4 Mettur reservoir

The regression of Y/f in kg (per coracle unit per year) or f in number of licensed coracle units per day for the period 1963-64 to 1983-84 (excluding 1965-66) is found to be :

$$\text{Schaefer : } Y/f = 955.6540 - 0.43813 f \quad \dots\dots\dots (15)$$

$$\text{Fox : } Y/f = \exp: 6.9393 - 0.00077 f \quad \dots\dots\dots (16)$$

The annual MSY is estimated to be 521,123 kg for the f_{msy} of 1,091 coracle units (Schaefer) and 492,746 kg for 1,298 coracle units (Fox) per day licensed to fish all round the year, but only about 50% of the total number of units operate on any given day. The 1100 coracle units operating round the year could be considered as the optimum effective fishing effort (the actual number of licences issued being

double the effective optimum. The r^2 value is extremely low(0.15) (for both Schaefer and Fox).

During the period 1963-64 to 1983-84, the annual catch ranged from 159,100 kg in 1977-78 for 430 coracle units to 579,540 kg in 1979-80 for 743 coracle units. The average annual catch was 351,374 kg and the average annual effort 494 coracle units. The number of licences issued remained at 305 to 320 from 1963-64 to 1972-73 except in 1968 -70 (408 to 428), but nearly doubled to 539 to 750 from 1974-75 onwards except in 1975-76 (463) and 1977-78 (430).

It is observed that fishing in Mettur reservoir has almost reached the MSY level of about 500 tons in recent years (1979-80, 1980-81 and 1981-82), for an annual effort of about 750 coracle units, which is somewhat less than the f_{msy} of 1000 to 1200 coracle units. The reservoir, which is used basically for irrigation purposes, has been experiencing severe drought in recent years when the water level generally remained low, facilitating the attainment of the MSY with fairly less effort than the f_{msy} .

The PDOMF group, the TLC group, the planktivores, the SLC group and the herbivores contributed 46.95%, 23.72%, 20.08%, 8.60% and 0.63% respectively to the average annual catch during 1963-64 to 1983-84. *L. rohita* (11.63%) and *C. cirrhosa* (8.31%) were dominant among the PDOMF group, *W. attu* (21.13%) was dominant in the TLC group, and *Mystus* spp (4.31%) and *Pangasius pangasius* (3.97%) in the SLC group, while the planktivores and herbivores comprised exclusively of *C. cafla* and *Puntius carnaticus* respectively. The lack of dominance by any single species low in the food chain may be due to the abundance of the TLC group. Therefore, it is worthwhile undertaking intensive longlining for *W. attu* so that the species low in the food chain, particularly the major carps, may become dominant in course of time.

5 Ooty lake

The regression Y/f in kg on annual f in gillnetdays for the period 1972-73 to 1981-82 is found to be :

$$\text{Schaefer} \quad : Y/f = 3.13942 - 0.00038744 f \quad \dots\dots (17)$$

$$\text{Fox} \quad : Y/f = \exp. 1.26379 - 0.00029042 f \quad \dots\dots (18)$$

The annual MSY for this period is 6,360 kg (Schaefer) and 5,684 kg (Fox) for the f_{msy} of 4,051 (Schaefer) gillnetdays and 4,366 gillnetdays (Fox) respectively. The value of r^2 is higher for the Fox estimate (0.47) than the Schaefer estimate (0.35).

The annual catch ranged from 2,340 kg in 1973-74 for the effort of 1,300 gillnetdays to 8,610 kg in 1978-79 for the effort of 2,100 gillnet days, while the mean annual catch was 5,325 kg for the mean annual effort of 3,225 gillnetdays. The f_{msy} of 4,366 gillnetdays is equivalent to 12 gillnets per day (4,366 gillnetdays divided by 365 days as fishing takes place all through the year) operated from an average of 2 boats at

the rate of 6 nets per boat (Table 1). The number of boats, however, was just one in 1972-73, 1973-74 and 1978-79, two from 1974-75 to 1977-78 and 1981-82 and three in 1979-80 and 1980-81. By virtue of its high altitude location and cold temperature, the fishery of this lake is almost exclusively comprised common carps, *Cyprinus carpio* var *specularis* (66.00%) and *C. carpio* var *communis* (33.34%), except incidental catches of *H. molitrix* (0.36%) and *C. idella* (0.3%) (Table 3).

Situated in the Ooty town at an altitude of 2500 m above the mean sea level, the lake has a maximum waterspread of 26.3 ha and maximum depth of 8.1 m. The town drainage is the main source of water for the lake. The temperature ranges from 0°C to 22°C. In spite of high altitude, cold climate, high transparency and other oligotrophic features, there is high level of organic production owing to copious discharges of municipal wastes into the lake (Sreenivasan, 1963; 1969 a). *Labeo* spp, *Puntius* spp and the golden carp (*Carassius auratus*) which once formed the mainstay of the fishery, disappeared after the introduction of *C. carpio* in the sixties. Indian major carps have failed to establish themselves despite repeated stockings on account of the low water temperature. However, the Chinese carps (*H. molitrix* and *C. idella*), planted in the seventies, show signs of adaptation, as evident from the occasional catches (Table 3).

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Table - 1. Dimensions and specifications of fishing nets and model of fishing in Tamil Nadu reservoirs

Name of reservoir	Description of one fishing unit	Dimensions of each gill net						Licencing or Departmental fishing
		Surface to midwater gillnet (Rangoon net)			Bottom set gillnet (uduvalai)			
		Running length m	Hanging depth m	Stretched mesh mm	Running length m	Hanging depth m	Stretched mesh mm	
Bhavanisagar	40 to 45 surface gillnets (Rangoon nets) and 3 to 4 bottom set gillnets (uduvalai) operated from a coracle by two fishermen	30 to 45 for gillnets (total 1200 m to 2025 m)	2 to 5	50 to 150 (50, 70, 75, 100, 125 & 150)	75 (total 225 m to 300 m)	0.75	37 & 75	Dept.
Sathanur	20 gillnets operated from a coracle by two fishermen	50 (total 1000 m)	4	-	-	-	-	Dept.
Amaravathy	10 Rangoon gillnets and 5 bottom set gillnets operated from a coracle by two fishermen	100 (total 1000 m)	2 to 5	62 for 3 nets of 100 m each; 112 for 15 nets of 100 m each	60 (total 300 m)	0.75	125	Dept.

contd.....

Mettur	10 to 15 Rangoon gillnets and 2 bottom set gillnets operated from a coracle by two fishermen	100 m (total 1000 m to 1500 m)	2	5	-do-	100 m (total 200 m)	0.75	50	Licencing
Ooty	5 gillnets (some- times a castnet is also used) operated from a motorised boat	100 (total 500 m)	4		55, 60 & 70	-	-	-	Departmental

Table - 2. Estimates of optimum yield and effort for reservoirs in Tamil Nadu

Name of the reservoir	Data period	Schaefer model $Y/f = a - bf$			Fox model $Y/f = \exp. a + bf$			Average annual catch (kg)	Average annual effort
		MSY (kg)	f_{msy}	r^2	MSY (kg)	f_{msy}	r^2		
Bhavanisagar	1971-72 to 1983-84	266,307	182,139	0.59	259,828	232,354	0.67	193,488	123,333
			gillnetdays			gillnetdays			gillnetdays
Sathanur	1966-67 to 1983-84	181,566	34	0.63	165,955	38	0.69	128,688	21
			coracle units per day			coracle units per day			coracle units per day
Amaravathy	1961-62 to 1983-84	182,550	3,855	0.35	83,960	3,833	0.21	71,520	2,507
			coracle days			coracle days			coracle days
Mettur	1963-64 to 1983-84	521,123	1,091	0.15	492,746	1,298	0.15	351,374	494
			coracle units per day			coracle units per day			coracle units per day
Ooty lake	1972-73 to 1981-82	6,360	4,051	0.34	5,684	4,366	0.47	5,325	3,225
			gillnetdays			gillnetdays			gillnetdays

Table - 3. Species composition and total catch of fish from Tamil Nadu reservoirs according to feeding categories, i.e., planktivores, herbivores, periphyton-cum-decaying organic matter feeders, second level carnivores and third level carnivores

A. Species low in the food chain	Bhavanisagar		Sathanur		Amaravathy		Mettur		Ooty lake
	1964	1977-78 to 1983-84	1977-78 to 1983-84	1977-78 to 1983-84	1977-78 to 1983-84	1977-78 to 1983-84	1963-64 to 1983-84	1980-81 to 1983-84	
I. Planktivores									
Catla catla	8.3	1.03	66.78	0.96			20.08	-	
Hypophthalmichthys molitrix	-	0.004	-	0.001			-	0.36	
Rhinomugil corsula	-	-	-	-			-	-	
Subtotal - I	8.3	1.034	66.78	0.961			20.08	0.36	
II. Herbivores									
Ctenopharyngodon idella	-	-	-	0.004			-	0.30	
Puntius carnaticus	0.7	0.03	-	1.01			0.63	-	
Subtotal - II	0.7	0.03	-	1.014			0.63	0.30	
III. Periphyton-cum-decaying organic matter feeders									
Labeo rohita	1.7	10.06	7.25	2.05			11.63	-	
Labeo fimbriatus	3.5	19.45	4.06	5.36			-	-	
Labeo calbasu	12.7	18.97	3.22	0.002			0.94	-	
Puntius puntius	3.6	-	-	0.003			-	-	
Labeo bata	5.9	2.04	-	0.03			-	-	
Cirrhinus mrigala	2.6	3.23	11.43	3.54			5.13	-	
Cirrhinus cirrhosa	0.5	-	1.71	-			8.31	-	
Cirrhinus reba	-	0.43	-	-			-	-	

Puntius hexagonolepis	1.4	-	-	-	-	-
Puntius sarana	0.01	3.19	-	-	-	-
Cyprinus carpio	0.02	0.49	0.28	4.83	-	99.34
Tilapia mossambica	-	1.71	0.0004	81.76	-	-
Others	-	4.45	0.45	-	20.94	-
Subtotal -III	31.93	64.02	28.40	97.575	46.95	99.34
Total (I,II & II)	40.93	65.084	95.18	99.55	67.66	100.00
B. Second level carnivores						
Mystus aor Mystus seenghala	21.3	20.59	2.72	0.04	4.31	-
Silondia silundia	-	-	-	-	0.32	-
Pangasius pangasius	-	-	-	-	3.97	-
Ompak bimaculatus	-	-	-	0.10	-	-
Puntius dubius	27.2	2.47	-	0.01	-	-
Etroplus suratensis	0.03	-	-	-	Negligible	-
Tor tor	0.45	0.005	-	0.008	-	-
Macrobrachium spp.	-	-	0.006	-	-	-
Total of B	48.98	23.065	2.726	0.158	8.60	-
C. Third level carnivores						
Channa marulius	0.01	-	-	-	-	-
Wallago attu	10.2	11.83	2.09	0.33	21.13	-
Anquilla bicolor	0.02	0.002	-	-	2.59	-
Total of C	10.23	11.832	2.09	0.33	23.72	-
ALL TOTAL (A,B & C)	100	100	100	100	100	100